Surveys For Basking Sharks (*Cetorhinus maximus*) and Other Pelagic Sharks on the Pacific Coast of Canada, 2007 - 2011

A.M. Surry and J.R. King

Fisheries and Oceans Canada
Science Branch, Pacific Region
Pacific Biological Station
Nanaimo, British Columbia
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Science Branch, Pacific Region
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Abstract

Surry, A.M., and King, J.R. 2015. Surveys for Basking Sharks (*Cetorhinus maximus*) and other pelagic sharks on the Pacific Coast of Canada, 2007 – 2011. Can. Tech. Rep. Fish. Aquat. Sci. 3108: vi + 28 p.

In 2007, the Pacific population of Basking Shark (*Cetorhinus maximus*) was assessed as Endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Aerial surveys were identified as one method for search and enumeration of Basking Sharks in historic areas of abundance. Therefore, 25 aerial surveys for Basking Sharks were conducted between 2007 – 2011 on the west coast of Vancouver Island and in Rivers Inlet, British Columbia. In addition, one offshore aerial survey and one offshore boat-based survey were conducted in 2011 on the west coast of Vancouver Island. No Basking Sharks were observed. However, numerous pelagic sharks such as Blue Sharks (*Prionace glauca*) and possibly Tope Sharks (*Galeorhinus galeus*) were observed on the offshore aerial and boat-based surveys. In addition, many marine mammals and other sightings were successfully observed and identified on all surveys, indicating that these surveys were effective for spotting animals when they were present. In 2007 – 2011, while aerial surveys were ongoing, reports of Basking Sharks to Fisheries and Oceans Canada (DFO) from members of the public were rare, with only four confirmed sightings, and five sightings considered likely. Coordinating future aerial surveys with reports of Basking Sharks provided to DFO by members of the public could increase the number of confirmed Basking Shark sightings.

Résumé

Surry, A.M., and King, J.R. 2015. Relevés des pèlerins (*Cetorhinus maximus*) et d'autres requins pélagiques sur la côte du Pacifique du Canada de 2007 à 2011. Rapp. tech. can. sci. halieut. aquat. 3108: vi + 28 p.

En 2007, le Comité sur la situation des espèces en péril au Canada (COSEPAC) a évalué la population de pèlerins (Cetorhinus maximus) dans les eaux canadiennes du Pacifique et l'a désignée comme espèce en voie de disparition. Il a été déterminé que les relevés aériens constituent une méthode pour le repérage et le dénombrement des pèlerins dans les aires d'abondance historiques. Par conséquent, 25 relevés aériens des pèlerins ont été menés entre 2007 et 2011 sur la côte ouest de l'île de Vancouver et dans le bras de mer Rivers, en Colombie-Britannique. En plus, un relevé aérien et un relevé sur un bateau ont été menés en 2011 dans les eaux du large de la côte ouest de l'île de Vancouver. Aucun pèlerin n'a été observé lors de ces relevés. Cependant, on a pu observer de nombreux requins pélagiques comme le requin bleu (*Prionace glauca*) et le requin-hâ (*Galeorhinus galeus*) lors des relevés dans les eaux du large de la côte. En plus, on a pu observer et identifier beaucoup des mammifères marins et d'autres animaux lors de tous les relevés, ce qui indique que ces relevés ont été efficaces pour repérer les animaux lorsqu'ils étaient présents. Entre 2007 et 2011, à la même époque que les relevés aériens, le public n'a signalé que très rarement des observations de pèlerins à Pêches et Océans Canada (MPO). En effet, quatre signalements ont été confirmés, et cinq signalements sont considérés comme étant probables. En coordonnant les futurs relevés aériens avec les observations de pèlerins rapportées au MPO par le public, le nombre de signalements de pèlerins confirmés pourrait augmenter.

Introduction

Basking Sharks (*Cetorhinus maximus*) are found circumglobally in surface waters of the temperate coastal shelf, and exist in Canada as two geographically separate populations in the Atlantic and Pacific (COSEWIC 2007). Basking Sharks in British Columbia (BC) waters are considered to be part of a North American Pacific coast population which migrates into BC waters in spring and summer (approximately May to September) and winters off California (McFarlane et al. 2009). Prior to 1970, large aggregations of Basking Sharks were common off BC, but by 2007, the population was thought to have declined by more than 90% from historic numbers (McFarlane et al. 2009). The dramatic decline is thought to be due to a directed fishery for liver oil (1941 – 1947) as well as an eradication program (1955 – 1969) which was carried out because of a conflict with commercial fishing (McFarlane et al. 2009).

In April 2007, the Pacific population of Basking Shark was assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as Endangered (COSEWIC 2007). Subsequently, in February 2010, the Pacific population of Basking Sharks was listed as Endangered under Canada's Species at Risk Act (SARA), affording it legal protection (http://laws-lois.justice.gc.ca/eng/acts/s-15.3/index.html; DFO 2011a). In response to the 2007 COSEWIC assessment of Basking Sharks, Fisheries and Oceans Canada (DFO) proposed a number of research and recovery promotion activities, including, among other initiatives, education and outreach programs, development of a sightings network, and aerial surveys for search and enumeration in historic areas of abundance (McFarlane et al. 2009).

Basking Sharks are the second largest shark in the world, exceeded only by the Whale Shark (*Rhincodon typus*), and are known to reach lengths of up to 10 m (Compagno 2001, Pauly 2002). Their large size, and habit of "basking" near the surface while feeding on plankton, make them ideal candidates for surveying via aerial means. Aerial surveys for Basking Sharks are not a new idea: aerial fish spotters were employed in the Basking Shark fishery of central California in the late 1940s (Squire 1967), and Basking Sharks were recorded on aerial surveys for various pelagic species off California by the National Marine Fisheries Service (NMFS) and the Southwest Fisheries Science Center (SWFSC) between 1962 and 2004 (Squire 1990, McFarlane et al. 2009). In addition, on the Atlantic coast of Canada, Basking Sharks were successfully recorded on aerial and shipboard cetacean surveys in the Bay of Fundy in 1979 – 2003 (Campana et al. 2008).

In addition to Basking Sharks, a number of other large (>2m) pelagic sharks utilize Canadian Pacific waters (DFO 2011b). Sightings of and encounters with Blue Sharks (*Prionace glauca*), Salmon Sharks (*Lamna ditropis*), and Tope Sharks (*Galeorhinus galeus*) are relatively common, while other pelagic species such as Shortfin Mako Sharks (*Isurus oxyrinchus*), Great White Sharks (*Carcharodon carcharias*), and Thresher Sharks (*Alopias vulpinis* and *A. superciliosus*) are rarely encountered. Tope Sharks are listed under SARA as a species of "Special Concern." Surveys that target Basking Sharks might reasonably be expected to encounter other pelagic shark species.

This report describes Basking Shark aerial surveys that were conducted in 2007 – 2011, as well as a pelagic shark aerial survey and boat-based survey that were conducted in 2011.

Methods

Identification of Basking Sharks and other Pelagic Sharks

Pelagic sharks, including Basking Sharks, can occur at or near the surface, both offshore and very close to land, including in enclosed bays and inlets, making visual identification possible

from the air or on the water (Compagno 2001). Basking Sharks are identifiable by their large size: up to 10 m (Pauly 2002); in addition, all pelagic sharks are readily distinguishable from marine mammals by the lack of "blows" and, when viewed from the air, the characteristically fish-like lateral motion of the tail. Basking sharks have very long gill slits which almost encompass the head; a pointed snout with a large, subterminal mouth; a large triangular dorsal fin, crescent shaped caudal fin, and caudal peduncle with strong lateral keels; the colour is greyish-brown to slate-grey to black on the body and fins, sometimes with lighter colouration on the ventral surface (Compagno 2001, DFO 2011b). Observers of Basking Sharks often report seeing the snout, dorsal fin, and caudal fin above the water at the same time.

Survey Platforms and Observers

Aerial surveys for Basking Sharks were conducted aboard chartered Cessna 180 and 182 float planes operating out of Port Alberni or Courtenay, British Columbia, flying at an airspeed of approximately 185 km/hr. The planes accommodated up to three observers in addition to the pilot; most flights had two observers. The primary observer was positioned in the front-right seat of the aircraft, while the secondary observer, if present, was positioned in the rear-left seat. Bubble windows were available for the pilot and primary observer. Two pilots and 17 different observers were involved in the survey series; however, on most flights, the primary observer was one of two people.

The boat-based survey was conducted aboard a chartered 8.8 m twin screw passenger vessel, operating out of Port Renfrew, British Columbia, cruising at a speed of approximately 30 km/hr. Two observers were on board the vessel in addition to the vessel captain.

Nearshore Aerial Surveys

The nearshore aerial surveys consisted of a set of aerial surveys in May – October 2007-2011. The survey timing was intended to coincide with the peak periods of historical encounters with Basking Sharks in British Columbia (McFarlane et al. 2009). Between two and eight surveys were conducted each year, as resources permitted. These aerial surveys focused on nearshore coastal areas and inlets on the west coast of Vancouver Island and at Rivers Inlet on the Central Coast of British Columbia, which are areas known to have been historically frequented by Basking Sharks (McFarlane et al. 2009). The same core areas were surveyed on every flight, but over time, additional search areas were added. A grid or transect pattern was not followed, as most areas surveyed were sufficiently narrow (e.g. inlets) or close to shore that the full area of interest was visible with a single pass or return loop. A zig-zag path was flown over wider areas such as Barkley sound to ensure full visibility of the area. Considerations such as localized weather, visibility, and sea state, as well as anecdotal information about aggregations of marine mammals and/or feed, and observations during the flight itself, influenced the exact flight path and the order in which areas were surveyed on each flight. Altitude during the observation part of each flight ranged from approximately 90 – 300 m (300 – 1000 feet) depending on weather conditions, location, and visibility.

West Coast Vancouver Island (WCVI)

Most flights originated in Port Alberni. The "Standard Route" for WCVI (Figure 1) covered Alberni Inlet to Pachena Bay, and Pachena Bay to Hesquiat Harbour, including Barkley Sound and associated inlets (Effingham Inlet and Pipestem Inlet), Clayoquot Sound, and Sydney Inlet and associated smaller inlets (Shelter Inlet, Stewardson Inlet). In general, one leg of each flight covered the "inside" (inlet) portion of the coastline, while the other leg covered the outer coast. The survey route varied over time, with Hesquiat Harbour excluded from the earliest flights, and

offshore fishing grounds on Swiftsure Bank and LaPerouse Bank included in later flights. One flight also included the northwest coast of Vancouver Island to Brooks Penninsula.

Rivers Inlet

Most flights originated in Courtenay. The "Standard Route" for Rivers Inlet (Figure 3) included Rivers Inlet, Moses Inlet, Hardy Inlet, Fitzhugh Sound south of Hecate Island, and the mouth of Smith Inlet. In general, the 2007 – 2009 flights did not survey the area between the flight origin (usually Courtenay) and Rivers Inlet, while the 2010 flights included the inside waters of Discovery Passage, Johnstone Strait, and Queen Charlotte Strait in the surveyed area. One flight also included the northwest coast of Vancouver Island from Nootka Sound to Kyuquot Sound.

Offshore Aerial and Boat Surveys

An additional aerial survey and a boat-based survey were conducted off the west coast of Vancouver Island in August 2011, to investigate whether searching further offshore than the coastal surveys would be effective in detecting Basking Sharks and other pelagic sharks, and whether boat-based surveys could be a useful tool, either instead of or in addition to aerial surveys. These surveys focussed on the marine banks and canyons between 10 and 100 km off Barkley Sound, and extended beyond the 200 m depth contour (Figure 4), to waters where pelagic sharks such as Blue Sharks (*Prionace glauca*) are encounted (J. King, unpublished).

The offshore aerial Survey originated in Port Alberni and included the area between Swiftsure Bank and Laperouse Bank, and between Nitnat Canyon and Father Charles Canyon, off Barkley Sound on the West Coast of Vancouver Island (Figure 4).

The offshore boat Survey originated in Port Renfrew and included the area beyond the 200m contour, between Nitnat Canyon and Barkley Canyon (Figure 4).

Data recording

In 2007 – 2009, neashore flight paths were drawn by hand on paper charts. As core flight paths for the nearshore surveys remained consistent, nearshore flight paths in 2010 – 2011 were recorded by noting waypoints at 20 minute intervals throughout the flight, where the location of waypoints were based on geographic names provided by the pilot. The nearshore flight paths were later drawn in ArcMap (ESRI 2010), using the paper charts, recorded waypoints, and other notes as a guide. The offshore surveys followed predetermined transects; the time at the start and end of each transect (waypoint) was noted. Route length for all surveys was estimated using the Measure tool in ArcMap.

For each nearshore aerial survey, altitude, weather conditions (an estimate of Beaufort Scale plus comments), and visibility were recorded at the start of the survey and whenever changes occurred. For the offshore aerial survey, altitude, weather conditions, and visibility were recorded at each waypoint and whenever an observation was recorded. For the boat survey, weather conditions were recorded at the start of the survey and whenever changes occurred.

Observations of cetaceans were recorded on all surveys. Observations of other taxonomic groups were recorded when especially noteworthy in 2007 – 2009, and for all surveys in 2010 – 2011. Observations included identification to the lowest taxonomic group possible, time, position, and where feasible, the number of individuals. Positions were either recorded directly as latitude and longitude by the observers, or estimated in ArcGIS based on geographic names or notations on charts. For the offshore aerial surveys, the declination angle to the observed animal was recorded using a Suunto™ clinometer.

A Canon Powershot S5IS digital camera was available to photograph potential sightings.

Results

Twenty-five nearshore aerial surveys were conducted between 2007 – 2011 on the west coast of Vancouver Island and in Rivers Inlet, British Columbia (Figure 1, Figure 2, and Figure 3). No Basking Sharks were observed, but a small number of other pelagic sharks were noted (Figure 1). Flight details, including observers, start and end times, duration, altitude, distance travelled, and weather conditions are summarized for each route in Table 1 and Table 2. Observations of cetaceans and other animals are provided in Table 3 and Table 4. Nearshore flights were numbered chronologically from 1 – 25.

One offshore aerial survey and one boat-based survey were conducted in 2011 on the west coast of Vancouver Island (Figure 4). No Basking Sharks were observed, but numerous other pelagic sharks were noted (Figure 4). Survey details, including observations of sharks, cetaceans and other animals are provided in Table 5 and Table 6.

Nearshore Surveys - West Coast Vancouver Island (WCVI)

Sixteen surveys were conducted on the west coast of Vancouver Island in 2007 (September 19), 2008 (May 9, September 5, October 3), 2009 (June 3, July 21, September 11), 2010 (May 14, June 21, July 23, August 30), and 2011 (May 30, June 23, July 27, August 25, September 28) (Table 1). The August 25, 2011 survey was extended to include the northwest coast of Vancouver Island from Hesquiat Peninsula to Brooks Peninsula. One pilot flew all the surveys. The primary observer on all surveys was one of M. Surry, S. McFarlane, J. King or R. McPhie, with J. King and/or R. McPhie covering 12 of the 16 surveys. Additional volunteer observers accompanied the primary observers on all but the first WCVI flight.

2007 – 2008 (Flights 2, 3, 4, 6)

In 2007 – 2008, all surveys except flight 3 generally followed the standard route, but excluded Hesquiat Harbour (Table 1, Figure 1). Average route length was 535 km, and all surveys except flight 3 remained within 3 km of shore when traversing the outer coast. Flight 3 in 2008 followed a more offshore route, extending as far as 13 km offshore between Vargus Island and Wickaninnish Bay, while flight 6 followed the standard route but added a southern portion between Pachena Bay and Tsusiat Falls. All cetacean sightings were recorded (Table 3), and included Humpback Whales (*Megaptera novaeangliae*), Grey Whales (*Eschrichtius robustus*), and unidentified cetaceans. In addition, Pinnipeds (Steller Sea Lions, *Eumetopias jubatus*), schools of Pacific Sardine (*Sardinops sagax*) or Pacific Herring (*Clupea pallasii*), and significant plankton blooms were recorded on some flights, but likely represent only the most notable sightings (Table 3).

2009 (Flights 8, 10, 12)

In 2009 all surveys followed the standard route (Table 1, Figure 1). Average route length was 533 km, and all flights remained within 3 km of the coast. A possible shark was observed momentarily on flight 8 in Bedwell Sound; however, the encounter was so short that it was not possible to identify the sighting, or even confirm that it was a shark (Figure 1). All cetacean sightings were recorded (Table 3) and included Humpback Whales, Grey Whales, Killer Whales (*Orcinus orca*), and unidentified cetaceans. Significant plankton blooms were noted on one flight (Table 3).

2010 (Flights 14, 16, 18, 20)

In 2010 all surveys followed the standard route (Table 1, Figure 1). Average route length was 524 km, and all flights remained within 3 km of the coast. All sightings attributable to a taxonomic group were recorded (Table 3). Cetacean sightings included Humpback Whales, Grey Whales, and a porpoise or dolphin. In addition, sightings of Sea Otters (*Enhydra lutris*), Steller Sea Lions and unidentified pinnipeds, plankton blooms, jellyfish, and large schools or Pacific Sardine or Pacific Herring were recorded. A Black Bear (*Ursus americanus*) was observed on flight 18 at the Bulson Creek Estuary in Fortune Channel.

2011 (Flights 21 – 25)

In 2011 all surveys followed the standard route (Table 1, Figure 1), but some flights included additional areas. Flights 21, 22, and 23 included the recreational fishing grounds on Swiftsure Bank and La Perouse Bank, south and west of Pachena Bay and Barkley Sound, following the survey route usually used for recreational creel surveys (B. Wright. Fisheries and Oceans Canada, 3225 Stephenson Point Road, Nanaimo, BC V9T 1K3, personal communication; Appendix A). Average route length of flights 21, 22, and 23 was 769 km. The fishing grounds portion of the route extended 40 km offshore; the remainder of the route was within approximately 10 km of shore when traversing the outer coast. Flight 24 did not include the creel route, but extended north to Brooks Peninsula (Figure 2), with a total route length of 925 km (420 km for the northwest coast portion) and remaining within about 5 km of shore. Flight 25 included Swiftsure Bank in addition to the Standard Route, but did not include the full creel route; the maximum distance offshore was approximately 14 km on Swiftsure Bank, with the remainder of the route remaining within about 5 km of shore, and a total length of 416 km.

All sightings attributable to a taxonomic group were recorded (Table 3). A possible blue shark (*Prionace glauca*) was observed on flight 21 on the way to Swiftsure Bank (Figure 1, Figure 5). Cetacean sightings included Humpback Whales, Grey Whales, porpoises or dolphins, and an unidentified cetacean. In addition, sightings of Sea Otters, Sea Lions, plankton blooms, jellyfish, large schools or Pacific Sardine or Pacific Herring, and an Ocean Sunfish (*Mola mola*) were recorded. A River Otter (*Lontra canadensis*) was observed on flight 22 in Sydney Inlet, while a Black Bear was observed on flight 25 in the Bedwell River Estuary.

Nearshore Surveys - Rivers Inlet

Nine surveys were conducted in the area of Rivers Inlet in 2007 (September 17), 2008 (September 26), 2009 (June 2, July 20, September 10), and 2010 (May 10, June 18, July 19, August 27) (Table 2). In addition, the July 19, 2009 survey included the northwest coast of Vancouver Island from Hesquiat Penninsula to Kyuquot Sound. One pilot flew all the surveys. The primary observer on all surveys was one of M. Surry, V. Hodes, J. King or R. McPhie, with J. King and/or R. McPhie covering seven of the nine surveys. Additional volunteer observers accompanied the primary observers on each survey.

2007 – 2009 (Flights 1, 5, 7, 9, 11)

In 2007 – 2009, surveys generally followed the standard route (Table 2, Figure 3). However, flight 1 did not include Hardy Inlet and Fitzhugh Sound; flight 7 included the return leg from Rivers Inlet to Courtenay (Queen Charlotte Strait, Johnstone Strait, Discovery Passage); and flight 9 included the northwest coast of Vancouver Island (Figure 2). The average route length was 199 km for flights surveying Rivers Inlet only, while flight 7 which included the return leg was 552 km. The northwest coast of Vancouver Island leg was 416 km. All cetacean sightings

were recorded (Table 4), and included Humpback Whales, Grey Whales, dolphins or porpoises, and unidentified cetaceans. Sightings of other taxonomic groups were not recorded.

2010 (Flights 13, 17, 19)

In 2010 surveys followed the standard route (Table 2, Figure 3) with the addition of the inside waters between Courtenay and Rivers Inlet on both legs of each flight (Discovery Passage, Johnstone Strait, Queen Charlotte Strait). Route length was approximately 813 km. All sightings attributable to a taxonomic group were recorded (Table 4). Of particular note was a sighting of approximately 50 Pacific White-Sided Dolphins (*Lagenorhynchus obliquidens*) on flight 19 near the mouth of Rivers Inlet. Other cetacean sightings included Humpback Whales, Grey Whales, Killer Whales, and unidentified cetaceans. Sightings of pinnipeds were also recorded. A Grizzly Bear (*Ursus arctos*) was observed on flight 19 in Moses Inlet.

Offshore Surveys - West Coast Vancouver Island (WCVI)

One offshore aerial survey was conducted on the west coast of Vancouver Island on August 30, 2011 (Table 5, Figure 4). This survey covered a total area of approximately 760,000 ha, with a flight path approximately 780 km long. The area surveyed was between 48.466° and 48.495° north latitude and 126.870° and 124.981° west longitude, extending from 10 - 100 km offshore, in the vicinity of Swiftsure Bank, Big Bank and Laperouse Bank, crossing the 200 m contour to the vicinity of Nitnat Canyon, Ucluelet / Loudon Canyons, and Father Charles Canyon. All sightings attributable to a taxonomic group were recorded (Table 5). Of particular note was a sighting of an unidentified shark between Swiftsure Bank and Big Bank, and a possible shark southwest of Father Charles Canyon (Figure 4; neither was a Basking Shark, based on size and shape). Other sightings included Humpback Whales, Gray Whales, Stellar Sea Lions and an Ocean Sunfish.

One offshore boat survey was conducted on the west coast of Vancouver Island on August 24, 2011 (Table 6, Figure 4). This survey covered a total area of approximately 71,000 ha, with a route length of approximately 194 km. The area surveyed was between 48.276° and 48.310° north latitude and 125.627° and 126.216° west longitude, extending from 60 – 80 km offshore, crossing the 200 m contour to the vicinity of Nitnat Canyon and Barkley Canyon. All sightings attributable to a taxonomic group were recorded (Table 5). Although no Basking Sharks were sighted, observers noted six Blue Sharks, one possible Tope Shark (*Galeorhinus galeus*), two unknown sharks, and two possible sharks (Figure 4). Other sightings included Humpback Whales, Pacific White-Sided Dolphins, Dall's Porpoise (*Phocoenoides dalli*), and Ocean Sunfish. Surveying from a boat provided the opportunity to see more identifying details of animals in close proximity to the boat, but the observers' line of sight was limited by factors such as glare and wave height.

Discussion

Aerial and boat-based surveys conducted in 2007 – 2011 of the west coast of Vancouver Island and Rivers Inlet failed to observe any Basking Sharks. However, the successful observation and identification of other pelagic sharks, numerous marine mammals, and other sightings of animals of smaller size than a basking shark, indicates that these surveys were effective for spotting animals when they were present (Figure 5).

Observers on offshore surveys, which occurred in an area where Blue Sharks are known to occur (J. King, unpublished), spotted more sharks than those on inshore surveys, providing further evidence that sharks are observable when they are present. The offshore aerial and boat surveys illustrate the tradeoff between surveying a large area from the air, where two

unidentified sharks were spotted, and surveying a much smaller area from the surface, where 11 sharks were spotted, of which seven were identifiable to species. Greater awareness among participants in vessel-based research survey programs may result in an increased number of vessel-based pelagic shark sightings in future.

One of the recommendations of McFarlane et al. (2009) was the development of a sightings network to coordinate and document Basking Shark sightings and encounters from the general public. Following the listing by COSEWIC of the Pacific Population of Basking Sharks as Endangered in 2007, DFO started actively seeking sightings reports from the public. Between September 2007 and September 2011, while the aerial surveys were ongoing, there were just four confirmed sightings of Basking Sharks in British Columbia, with an additional five sightings considered likely. Four of the sightings were off the west coast of Vancouver Island, while the rest were in areas not covered by the aerial surveys (J. King, unpublished data). In addition, other DFO programs conducting aerial surveys in similar areas during the same time period did not observe any Basking Sharks (Appendix A, Figure A1, Figure A2).

At the start of the aerial survey program and sightings network, it was hoped that sightings reports would be near-realtime, and that survey efforts could be focused in areas of known and recent sightings, thus increasing the likelihood of detecting Basking Sharks. However, the rarity of sightings and the relative remoteness of the areas where they have occurred has meant that considerable time usually passes between the sighting event and DFO receiving the report, making such coordinated surveying unfeasible.

Given the increasing awareness of the sightings network, if resources for aerial surveys are available, then coordinated surveying could increase the number of confirmed Basking Shark Sightings.

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Table 1. Basking shark nearshore aerial surveys for the West Coast of Vancouver Island in 2007 – 2011. The "standard route" includes Alberni Canal, and the west coast and inlets between Pachena Bay and Hesquiat Harbour (Figure 1). Note that Flight 24 in 2011 includes a survey leg (24a) over the northwest coast of Vancouver Island (Figure 2). Distance is the estimated length of the flight path (km). BFS is the Beaufort Scale code for weather and sea-state (Table 7).

Year	Flight	Route Details	Date	Time (HH:MM)			Observers		Altitude		Distance	Weather	
				Start	End	Duration	No.	Names	(ft)	(m)	(km)	BFS	Notes
2007	2	Pachena Bay to Sydney Inlet	Sep 19	11:25	14:45	03:20	1	Surry	650 - 900	198 - 274	548	2	Sunny
2008	3	Pachena Bay to Sydney Inlet (mainly outside)	May 9	11:02	14:00	02:58	2	Surry & volunteer	650 - 1100	198 - 335	480	2	some sun; mainly cloudy/overcast
	4	Pachena Bay to Sydney Inlet	Sep 5	09:06	12:47	03:41	2	Surry & McFarlane	500	152	590	0	Foggy; vis about 600 ft but lifting
	6	Tsusiat Falls to Sydney Inlet	Oct 3	11:00	13:45	02:45	2	McFarlane & Volunteer	650-900 (estimate)	198 - 274 (estimate)	494	1-4	some wind, light rain; inlets calm but waves offshore
2009	8	Standard route	Jun 3	10:17	13:59	03:42	2	King & Hodes	1000	305	550	1	wind calm; good visibility
	10	Standard route	Jul 21	10:23	13:30	03:07	2	King & Volunteer	1000	305	544	1-2	Sunny ; slight fog Bamfield to Cox Point.
	12	Standard route	Sep 11	10:12	13:50	03:38	2	King, McFarlane & Volunteer	1000	305	504	0-1	Sunny, calm; good visibility
2010	14	Standard route	May 14	09:55	13:10	03:15	2	McPhie & Volunteer	1000	304	543	0-1	sunny, some clouds
	16	Standard route	Jun 21	09:40	15:25	05:45	2	McPhie & King	300	91	546	1-2	overcast, low cloud; good visibility
	18	Standard route	Jul 23	08:30	11:50	03:20	2	McPhie & King	400-700	122-213	481	2-4	clear but difficult glare on outside waters
	20	Standard route	Aug 30	09:45	14:20	04:35	2	McPhie & Volunteer	1000	304	526	0-1	clear, sunny; some glare but visibility good
2011	21	Standard route plus banks	May 30	09:30	12:45	03:15	2	McPhie & King	800	244	732	2-3/4	overcast; low clouds but clear over inlets; good visibility
	22	Standard route plus banks	Jun 23	10:00	14:10	04:10	2	McPhie & Volunteer	700-900	213-274	834	3-4	windy; moderate visibilty
	23	Standard route plus banks	Jul 27	08:55	12:20	03:25	2	McPhie & Volunteer	700-1000	213-304	740	2-3	overcast, low cloud, some fog near coast; good visibility
	24	Standard route but excluding Alberni Inlet (Ucluelet start)	Aug 25	09:43	15:16	02:47	2	McPhie & Volunteer	700	213	505	2	Dense fog Toquart to Florencia; sunny elsewhere
	24a	Nootka Sound to Brooks Penninsula	Aug 25	11:55	14:41	02:46	2	McPhie & Volunteer	700	213	420	2	Sunny
	25	Standard route plus banks	Sep 28	09:15	13:30	04:15	2	McPhie & Volunteer	800	244	649	0-1	sunny; some glare but visibility good

Table 2. Basking shark nearshore aerial surveys for Rivers Inlet in 2007 – 2010. The "standard route" includes Rivers Inlet, Moses Inlet, Hardy Inlet, and the southern portion of Fitzhugh Sound. The "Inside" includes Discovery Passage, Johnstone Strait, and Queen Charlotte Strait (Figure 3). Note that Flight 9 in 2009 includes a survey leg (9a) over the northwest coast of Vancouver Island (Figure 2). Distance is the estimated length of the flight path (km). BFS is the Beaufort Scale code for weather and sea-state (Table 7).

Year	Flight	Route Details	Date	Time (HH:MM)			Observers		Altitude		Distance	Weather	
				Start	End	Duration	No.	Names	(ft)	(m)	(km)	BFS	Notes
2007	1	Rivers Inlet only (excludes Hardy Inlet & Fitzhugh Sound)	Sep 17	12:40	13:50	01:10	2	King & McFarlane	2300 (lower in inlet)	701	199	2	Sunny, light cloud cover
2008	5	Standard route	Sep 26	13:30	14:40	01:10	2	Surry & Hodes	1000	305	187	0-1	light rain
2009	7	Standard route plus Inside (x1)	Jun 2	11:27	12:51	01:24	2	King & Hodes	1500	457	552	1-2	wind calm
	9a	Nootka Sound to Quatsino Sound	Jul 20	09:40	11:45	02:05	2	King & Volunteer	1000	305	416	2	Sunny, sight overcast; good visibility
	9	Standard route	Jul 20	13:40	14:40	01:00	2	King & Volunteer	1000	305	169	3	Sunny, clear
	11	Standard route	Sep 10	11:28	13:27	01:59	2	Hodes & Volunteer	1000	305	240	2-3	Overcast to light cloud; good visibility
2010	13	Standard route plus Inside	May 10	10:06	15:21	05:15	2	McPhie & Volunteer	500-1000	152-304	813	2-3	sunny overcast with high cloud; good visibility
	15	Standard route plus Inside	Jun 18	09:57	14:55	04:58	2	McPhie & McFarlane	800 - 1000	244-304	813	2-3	overcast; high cloud; ; good visibility
	17	Standard route plus Inside	Jul 19	10:15	15:05	04:50	2	McPhie & Volunteer	400-1000	122-304	813	3-4	sunny at Courtenay; some fog/mist Rivers Inlet; good visibility
	19	Standard route plus Inside	Aug 27	10:10	14:30	04:20	2	McPhie & Volunteer	800-1000	244-304	813	0-1	cloudy / overcast, some rain; good visibility

Table 3. Detailed observations from Basking Shark nearshore aerial surveys for the West Coast of Vancouver Island in 2007 – 2011. Sightings marked with an asterisk (*) were possible identifications only.

Year	Flight	Sighting Information			Location Description	Longitude	Latitude	Time (HH:MM)
		Type	Species Common Name	No.				
2007	2	Cetaceans	Humpback Whales	1	Toquart Bay (Barkley Sound)	-125.345	49.025	12:57
		Cetaceans	Humpback Whales	1	Broken Group (Barkley Sound)	-125.359	48.920	12:41
		Pinnipeds	Sea Lions	--	Vernon Bay (Barkley Sound)	-125.146	48.990	--
		Fish & Plankton	Sardine/Herring	--	Vernon Bay (Barkley Sound)	-125.146	48.990	--
		Fish & Plankton	Sardine/Herring	--	Effingham Inlet (Barkley Sound)	-125.149	49.041	--
2008	3	Cetaceans	Gray Whales	1	Hotsprings Cove	-126.245	49.358	--
		Cetaceans	Humpback Whales	3	Off Lennard Light	-126.034	49.038	--
		Cetaceans	Humpback Whales*	1	Off Amphitrite Point	-125.689	48.952	--
	4	Cetaceans	Humpback Whales	1	Outside Mayne Bay (Barkley Sound)	-125.338	48.982	10:01
		Cetaceans	Humpback Whales	1	Peacock Channel (Barkley Sound)	-125.304	48.933	10:14
		Cetaceans	Humpback Whales	1	Wickaninnish Bay	-125.767	49.053	10:35
		Pinnipeds	Sea Lions	--	Diana Island (Barkley Sound)	-125.207	48.862	10:05
		Fish & Plankton	Jellyfish	--	Bedwell Sound (Clayoquot Sound)	-125.812	49.295	10:50
		Fish & Plankton	Plankton blooms	--	Tofino Inlet	-125.634	49.203	12:09
	6	Cetaceans	Humpback Whales	5	Off Pachena Bay	-125.102	48.699	11:19
		Cetaceans	Unidentified	1	Not recorded	--	--	13:36
2009	8	Sharks*	Unidentified	1	Bedwell Sound (Clayoquot Sound)	-125.812	49.295	13:00
		Cetaceans	Gray Whales	1	Bartlet Island (off Flores Island)	-126.011	49.146	12:36
		Cetaceans	Killer Whales	5	NE end of Deer Group (Barkley Sound)	-125.450	48.912	13:59
		Cetaceans	Unidentified	1	Outside Effingham Island (Barkley Sound)	-125.311	48.849	11:18
	10	Cetaceans	Gray Whales	2	Pachena Bay	-125.132	48.777	--
	12	Cetaceans	Humpback Whales	4	Imperial Eagle Channel (Barkley Sound)	-125.206	48.896	--
		Cetaceans	Humpback Whales	2	Entrance to Sydney Inlet	-126.249	49.336	--
		Cetaceans	Humpback Whales	1	Alberni Inlet (Macktush)	-124.820	49.110	--
		Cetaceans	Humpback Whales	1	Toquart Bay (Barkley Sound)	-125.345	49.025	--
		Cetaceans	Gray Whales	1	Cow Bay (Flores Island)	-126.155	49.249	--
		Cetaceans	Unidentified	1	Effingham Inlet (Barkley Sound)	-125.149	49.041	--
		Fish & Plankton	Plankton blooms	--	Head of Shelter Inlet (Sydney Inlet)	-126.055	49.428	--
		Fish & Plankton	Plankton blooms	--	Head of Sydney Inlet	-126.289	49.495	--
		Fish & Plankton	Plankton blooms	--	Hesquiat Harbour	-126.443	49.425	--
		Fish & Plankton	Plankton blooms	--	Bedwell Sound (Clayoquot Sound)	-125.812	49.295	--
2010	14	Cetaceans	Gray Whales	2	Cow Bay (Flores Island)	-126.155	49.249	--
	16	Cetaceans	Gray Whales	1	Rafael Point (Flores Island)	-126.240	49.280	13:00
		Cetaceans	Gray Whales	4	Effingham Island (Barkley Sound)	-125.284	48.867	--
		Cetaceans	Gray Whales	1	Diana Island (Barkley Sound)	-125.207	48.862	10:20
		Cetaceans	Humpback Whales	1	Broken Group (Effingham Island)	-125.284	48.867	--
		Cetaceans	Humpback Whales*	1	Diana Island (Barkley Sound)	-125.207	48.862	10:20
		Cetaceans	Dolphins/Porpoises	1	Useless Inlet (Barkley Sound)	-125.057	48.989	10:30
		Sea Otters	Sea Otters	--	Hesquiat Harbour	-126.443	49.425	--
	18	Cetaceans	Gray Whales	3	Rafael Point (Flores Island)	-126.240	49.280	10:50

Table 3. (Continued)

Year	Flight	Sighting Information			Location Description	Longitude	Latitude	Time (HH:MM)
		Type	Species Common Name	No.				
2010	18	Pinnipeds	Unidentified	2	Hesquiat Point (Hesquiat Harbour)	-126.430	49.408	10:45
		Sea Otters	Sea Otters	25	Sydney Inlet	-126.275	49.472	10:20
		Sea Otters	Sea Otters	--	Hesquiat Point (Hesquiat Harbour)	-126.430	49.408	10:45
		Fish & Plankton	Plankton blooms	--	Shelter Inlet (Sydney Inlet)	-126.104	49.425	10:15
		Fish & Plankton	Jellyfish	--	Hesquiat Point (Hesquiat Harbour)	-126.430	49.408	10:45
		Land animals	Black Bear	1	Bulson Creek Estuary (Fortune Channel)	-125.730	49.260	--
	20	Cetaceans	Humpback Whales*	1	Pachena Bay	-125.132	48.777	--
		Cetaceans	Humpback Whales	1	Wickaninnish Bay	-125.741	49.019	--
		Cetaceans	Humpback Whales	1	Toquart Bay (Barkley Sound)	-125.345	49.025	10:40
		Cetaceans	Gray Whales	3	Estevan Point (Hesquiat Peninsula)	-126.566	49.389	--
		Cetaceans	Gray Whales	1	Wickaninnish Bay	-125.741	49.019	11:20
		Cetaceans	Gray Whales	2	Outside Pachena Bay	-125.158	48.759	--
		Cetaceans	Gray Whales	1	Pachena Bay	-125.132	48.777	10:20
		Pinnipeds	Sea Lions	--	Toquart Bay (Barkley Sound)	-125.345	49.025	10:40
		Fish & Plankton	Sardine/Herring	--	Sarita River (Barkley Sound)	-125.038	48.901	--
		Fish & Plankton	Sardine/Herring	--	Estevan Point (Hesquiat Peninsula)	-126.566	49.389	--
		Fish & Plankton	Sardine/Herring	--	Toquart Bay (Barkley Sound)	-125.345	49.025	10:40
		Fish & Plankton	Plankton blooms	--	Pachena Bay	-125.132	48.777	10:20
		Fish & Plankton	Plankton blooms	--	Estevan Point (Hesquiat Peninsula)	-126.566	49.389	--
2011	21	Sharks	Blue Shark*	1	On the way to Swiftsure Bank	-124.822	48.540	--
		Cetaceans	Humpback Whales	4	Swiftsure Bank	-124.988	48.566	--
		Cetaceans	Humpback Whales	12	Between banks off Cape Beale (7-mile Bank)	-125.268	48.660	--
		Cetaceans	Humpback Whales	3	La Perouse Bank	-125.690	48.644	--
		Pinnipeds	Sea Lions	4	Estevan Point (Hesquiat Peninsula)	-126.558	49.369	--
		Pinnipeds	Sea Lions	--	Perez Rocks (Hesquiat Peninsula)	-126.609	49.413	--
		Sea Otters	Sea Otters	--	Estevan Point (Hesquiat Peninsula)	-126.558	49.369	--
	22	Cetaceans	Gray Whales	2	South of Hesquiat Harbour	-126.481	49.333	13:00
		Cetaceans	Gray Whales	3	Rafael Point (Flores Island)	-126.240	49.280	13:20
		Cetaceans	Humpback Whales	4	Rafael Point (Flores Island)	-126.240	49.280	13:20
		Cetaceans	Humpback Whales	1	Estevan Point (Hesquiat Peninsula)	-126.558	49.369	--
		Cetaceans	Humpback Whales	1	Between La Perouse Bank and Barnfield	-125.906	48.805	11:00
		Cetaceans	Humpback Whales	11	Between Pachena and La Perouse Bank	-125.847	48.615	10:40
		Cetaceans	Dolphins/Porpoises	--	South of Hesquiat Harbour	-126.481	49.333	13:00
		Cetaceans	Dolphins/Porpoises	1	North of Vargus Island	-126.021	49.229	12:20
		Fish & Plankton	Jellyfish	--	South of Hesquiat Harbour	-126.481	49.333	13:00
		Land animals	River Otter	1	Sydney Inlet	-126.023	49.311	12:40
	23	Cetaceans	Humpback Whales	1	South of Wickaninnish Bay	-125.683	48.983	--
		Cetaceans	Humpback Whales	1	Swiftsure Bank	-124.988	48.566	--
		Cetaceans	Humpback Whales	2	Between Swiftsure Bank and La Perouse Bank	-125.481	48.526	--
		Cetaceans	Humpback Whales	8	La Perouse Bank	-125.847	48.615	--
		Pinnipeds	Sea Lions	6	Swiftsure Bank	-124.988	48.566	--

Table 3. (Continued)

Year	Flight	Sighting Information			Location Description	Longitude	Latitude	Time (HH:MM)
		Type	Species Common Name	No.				
2011	23	Pinnipeds	Sea Lions	1	Cape Beale	-125.241	48.782	--
		Pinnipeds	Sea Lions	2	Outside Pachina Bay	-125.158	48.759	--
	24	Cetaceans	Gray Whales	3	Mouth of Hesquiat Harbour	-126.499	49.359	11:45
		Cetaceans	Gray Whales	6	Rafael Point (Flores Island)	-126.270	49.297	14:50
		Cetaceans	Humpback Whales	2	Florencia Bay (South of Wickaninnish)	-125.646	48.969	15:08
		Cetaceans	Humpback Whales	3	Vargas Island	-125.962	49.092	15:00
		Cetaceans	Small cetacean		Hesquiat Harbour	-126.430	49.408	11:35
		Pinnipeds	Sea Lions	4	North of Hesquiat Harbour	-126.566	49.389	--
		Pinnipeds	Sea Lions	--	Effingham Inlet (Barkley Sound)	-125.149	49.041	10:12
		Sea Otters	Sea Otters	--	Hesquiat Harbour	-126.430	49.408	11:35
		Fish & Plankton	Sardine/Herring	--	North of Hesquiat Harbour	-126.566	49.389	--
		Fish & Plankton	Sardine/Herring	--	Hesquiat Harbour	-126.430	49.457	11:40
		Fish & Plankton	Sardine/Herring	--	Effingham Inlet (Barkley Sound)	-125.149	49.041	10:12
		Fish & Plankton	Plankton blooms	--	Bedwell Sound (Clayoquot Sound)	-125.812	49.295	10:50
	24a	Cetaceans	Humpback Whales	2	Checleset Bay	-127.637	50.117	13:47
		Cetaceans	Gray Whales	3	Nootka Sound	-126.586	49.472	11:55
		Cetaceans	Gray Whales	8	Nootka Sound	-126.600	49.432	11:50
		Pinnipeds	Sea Lions	4	Nootka Sound	-126.600	49.432	11:50
		Sea Otters	Sea Otters	20	Kashutl Inlet (Kyuquot Sound)	-127.305	50.163	13:30
		Fish & Plankton	Ocean Sunfish	2	Union Island	-127.341	49.935	14:20
		Fish & Plankton	Ocean Sunfish	1	Checleset Bay	-127.637	50.117	13:45
	25	Cetaceans	Humpback Whales	1	Vargas Island (five miles offshore)	-126.098	49.091	--
		Pinnipeds	Sea Lions	2	Effingham Inlet (Barkley Sound)	-125.149	49.041	--
		Pinnipeds	Sea Lions	--	Perez Rocks (Hesquiat Penninsula)	-126.609	49.413	--
		Pinnipeds	Sea Lions	--	Pretty Girl Cove (Sydney Inlet)	-126.240	49.471	--
		Pinnipeds	Sea Lions	--	Sydney Inlet	-126.243	49.432	--
		Pinnipeds	Sea Lions	--	Bedwell Sound (Clayoquot Sound)	-125.812	49.295	11:20
		Pinnipeds	Sea Lions	--	Pipestem Inlet (Barkley Sound)	-125.292	49.022	10:40
		Pinnipeds	Sea Lions	1	Head of Effingham Inlet (Barkley Sound)	-125.185	49.090	--
		Pinnipeds	Sea Lions	4	Swiftsure Buoy	-124.988	48.566	--
		Pinnipeds	Sea Lions	2	Between Carmanah and Swiftsure	-124.822	48.540	--
		Pinnipeds	Sea Lions	3	Carmanah Lighthouse	-124.762	48.594	09:52
		Pinnipeds	Sea Lions	--	Pachena Lighthouse	-125.102	48.699	09:45
		Pinnipeds	Sea Lions	--	Alberni Inlet	-125.030	48.951	--
		Sea Otters	Sea Otters	--	Estevan Point (Hesquiat Penninsula)	-126.566	49.389	12:00
		Fish & Plankton	Ocean Sunfish	1	Between Swiftsure Bank and Pachena Bay	-125.102	48.699	10:07
		Fish & Plankton	Sardine/Herring	--	Wickaninnish Bay	-125.831	48.973	12:40
		Fish & Plankton	Sardine/Herring	--	Effingham Inlet (Barkley Sound)	-125.149	49.041	--
		Land animals	Black Bear	1	Bedwell River Estuary (Clayoquot Sound)	-125.777	49.358	13:20

Table 4. Detailed observations from Basking Shark nearshore aerial surveys of Rivers Inlet in 2007 – 2010. Sightings marked with an asterisk (*) were possible identifications only.

Year	Flight	Sighting Information			Location Description	Longitude	Latitude	Time (HH:MM)
		Type	Species Common Name	No.				
2007	1	Cetaceans	Humpback Whales	--	Mouth of Rivers Inlet	-127.714	51.421	13:10
		Cetaceans	Humpback Whales	--	Stone Point (Rivers Inlet)	-127.529	51.615	13:00
2008	5	Cetaceans	Unidentified cetaceans	1	Fitzhugh Sound	-127.834	51.424	--
		Cetaceans	Unidentified cetaceans	1	Not recorded	--	--	--
2009	7	Cetaceans	Dolphins/Porpoises	--	Malcolm Island (Queen Charlotte Strait)	-126.758	50.653	--
		Cetaceans	Gray Whales	--	Malcolm Island (Queen Charlotte Strait)	-126.758	50.653	--
	9a	Cetaceans	Gray Whales	2	Bajo Point (Nootka Island)	-126.853	49.621	--
	9	Cetaceans	Gray Whales	--	Off Cape Calvert	-127.834	51.424	--
		Cetaceans	Unidentified cetaceans	2	Roller Bay	-127.941	50.935	--
	11	No observations recorded.						
2010	13	Cetaceans	Humpback Whales*	1	Addenbroke Island (Fitzhugh Sound)	-127.861	51.590	13:22
		Cetaceans	Unidentified cetaceans	1	Addenbroke Island (Fitzhugh Sound)	-127.861	51.590	13:22
		Pinnipeds	Sea Lions	--	Ripple Passage (Port Hardy)	-127.467	50.903	--
	17	Cetaceans	Killer Whales	--	Hanson Island (Telegraph Cove)	-126.807	50.574	11:25
		Cetaceans	Humpback Whales*	2	Home Bay, Open Bight (Mouth of Rivers Inlet)	-127.715	51.420	13:45
		Cetaceans	Humpback Whales	1	Across from Lucy Bay (?) (Mouth of Smith Sound)	-127.820	51.332	13:55
		Cetaceans	Unidentified cetaceans	--	Entrance to Rivers Inlet (outside large island)	-127.755	51.447	13:50
		Cetaceans	Unidentified cetaceans	--	Entrance to Rivers Inlet	-127.612	51.455	13:10
		Pinnipeds	Seals	--	Home Bay, Open Bight (Mouth of Rivers Inlet)	-127.715	51.420	13:45
		Pinnipeds	Sea Lions	--	Lucy Bay (Mouth of Smith Sound)	-127.799	51.332	13:00
	19	Cetaceans	Killer Whales	4	St. Vincent Bight (Johnstone Strait)	-126.161	50.461	--
		Cetaceans	Killer Whales	--	Robson Bight (Johnstone Strait)	-126.591	50.500	--
		Cetaceans	Gray Whales	1	Irving Passage (mouth of Smith Sound)	-127.812	51.314	--
		Cetaceans	Gray Whales	2	Mouth of Rivers Inlet	-127.715	51.420	--
		Cetaceans	Gray Whales*	1	Hardy Inlet	-127.552	51.698	--
		Cetaceans	Humpback Whales	1	Malcolm Island (Queen Charlotte Strait)	-126.787	50.639	13:40
		Cetaceans	Dolphins/Porpoises	50	Mouth of Rivers Inlet	-127.715	51.420	--
		Land animals	Grizzly bear	1	Moses Inlet	-127.371	51.826	12:40

Table 5. Basking shark offshore aerial survey on the West Coast of Vancouver Island, August 30, 2011, with detailed observations. Survey route with waypoints is shown in Figure 4 . Distance is the estimated length of the flight path (km). BFS is the Beaufort Scale code for weather and sea-state (Table 7). Sightings marked with an asterisk (*) were possible identifications only.

Flight Summary

Route Details	Date	Time (HH:MM)			Observers		Altitude		Distance (km)	Weather
		Start	End	Duration	No.	Names	(ft)	(m)		
Swiftsure, Laperouse & Big Banks Nitnat, Barkley, Ucluelet/Loudon, Father Charles Canyons	Aug 30	09:37	15:02	05:25	2	King & Volunteer	500 – 700	152 – 213	780	Overcast

Flight Details

Waypoint	Longitude	Latitude	Time (HH:MM)	Altitude		Visibility (km)	BFS	Sighting Information			
				(ft)	(m)			Type	Species Common Name	No.	Angle
LT01	-124.981	48.595	09:37	600	183	>10	4	--	--	--	--
LT02	-125.507	48.247	10:00	600	183	>10	5	Cetaceans	Humpback Whales	10	15°
LT03	-125.643	48.321	10:05	--	--	>10	5	--	--	--	--
--	-125.409	48.512	10:15	600	183	>10	3	Sharks	Unidentified	2	70°
--	-125.392	48.512	10:17	--	--	>10	3	Pinnipeds	Sea Lions	6	37°
LT04	-125.155	48.647	10:23	--	--	>10	3	--	--	--	--
LT05	-125.293	48.718	10:27	--	--	>10	3	--	--	--	--
LT06	-126.247	48.087	11:01	650		>10	6	--	--	--	--
LT07	-126.385	48.160	11:03	700	213	>10	6	--	--	--	--
--	--	--	11:23	--	--	--	4	--	--	--	--
--	-125.932	48.471	11:24	700	213	>10	4	Cetaceans	Humpback Whales	1	17°
LT08	-125.423	48.792	11:40	650	198	8 (some fog)	0	Cetaceans	Humpback Whales	2	14°
LT09	-125.568	48.861	11:44	650	198	8	0	--	--	--	--
LT09	-125.568	48.861	12:31	700	213	>10	1	--	--	--	--
--	-125.703	48.783	12:35	700	213	>10	1	Cetaceans	Gray Whales	1	40°
--	-125.780	48.734	12:37	700	213	>10	1	Cetaceans	Humpback Whales	2	80°
--	-126.388	48.360	12:59	--	--	>10	5	--	--	--	--
LT10	-126.507	48.240	13:05	700	213	>10	5	Fish & Plankton	Ocean sunfish	1	40°
LT11	-126.640	48.312	13:11	600	183	>10	6	--	--	--	--
--	-125.781	48.904	13:45	500	152	>10	0	Cetaceans	Humpback Whales	1	5°
LT12	-125.710	48.917	13:46	500	152	>10	0	--	--	--	--
LT13	-125.850	48.987	13:50	600	183	>10	1	--	--	--	--
	-125.914	48.958	13:52	600	183	>10	1	Cetaceans	Humpback Whales	2	23°
LT14	-126.756	48.382	14:21	600	183	>10	6	--	--	--	--
LT15	-126.878	48.466	14:28	600	183	>10	6	--	--	--	--
--	-126.625	48.643	14:39	700	213	>10	5	Sharks*	Unidentified	1	26°
--	--	--	14:55	700	213	>10	4	Cetaceans	Humpback Whales	1	27°
--	-126.203	48.965	14:56	700	213	>10	4	Cetaceans	Humpback Whales	1	15°
LT16	-125.983	49.046	15:02	700	213	>10	2	Cetaceans	Humpback Whales	1	23°

Table 6. Basking shark offshore boat-based survey on the West Coast of Vancouver Island, August 24, 2011, with detailed observations. Survey route with waypoints is shown in Figure 4 . Distance is the estimated length of the survey route (km). BFS is the Beaufort Scale code for weather and sea-state (Table 7). Sightings marked with an asterisk (*) were possible identifications only.

Survey Summary								
Route Details	Date	Time (HH:MM)			Observers		Distance (km)	General Weather Comments
		Start	End	Duration	No.	Names		
Barkley and Nitnat Canyons	Aug 24	09:37	17:00	07:23	2	McPhie & Volunteer	194	sunny the whole route, therefore glare unless looking almost directly down

Survey Details									
Waypoint	Longitude	Latitude	Time (HH:MM)	Weather		Sighting Information			
				BFS	Notes	Type	Species Common Name	No.	Comments
W001	-125.89	48.437	09:37	2	no whitecaps	--	--	--	--
--	--	--	09:42	--	--	Cetaceans	Humpback Whales	2	on horizon
--	--	--	10:02	--	--	Cetaceans	Pacific Whitesided Dolphins	many	breaching
W002	-126.216	48.314	10:30		sun coming out	--	-	--	--
W002	-126.216	48.314	10:35	2-3	--	--	--	--	--
--	--	--	11:20	--	--	Fish & Plankton	Ocean sunfish	1	right off starboard side
--	--	--	11:27	--	--	Cetaceans	Humpback Whales	4	right off port side
W003	-125.828	48.395	11:30	--	--	--	--	--	--
W003	-125.828	48.395	11:40	--	--	--	--	--	--
--	--	--	11:41	--	--	Cetaceans	Humpback Whales	1	port side, half way to horizon
--	--	--	11:45	--	--	Cetaceans	Unknown	1	saw a single blow, twice
--	--	--	11:53	--	--	--	--	--	--
--	--	--	11:55	--	--	--	--	--	--
--	--	--	12:00	--	--	Cetaceans	Pacific Whitesided Dolphins	a few	--
--	--	--	12:31	--	--	--	--	--	--
W004	-126.154	48.278	12:32	--	--	--	--	--	--
--	-126.129	48.268	12:41	--	--	Sharks	Unknown	1	Dark fin, looked brown, swam away quickly; 60-70 cm dorsal fin
--	-126.033	48.208	13:10	--	--	Sharks	Blue Shark	1	small, attacking log; white underbelly
--	-125.997	48.175	13:22	--	--	Sharks	Unknown	1	blue-gray, possibly with white; near log; sunning itself; scared away by boat
W0010	-125.959	48.157	13:34	1-2	calmer; no whitecaps	--	--	--	--
--	--	--	13:45	--	--	Cetaceans	Dall's Porpoise	2	--
--	--	--	13:50	--	--	Fish & Plankton	Ocean Sunfish*	1	--
--	-125.838	48.199	13:52	--	--	Sharks	Tope Shark *	1	small, brownish - saw underwater
--	-125.838	48.211	14:00	--	--	Sharks	Blue Shark	1	small
--	-125.803	48.214	14:05	--	--	Sharks	Blue Shark	1	small
--			14:23	--	--	Sharks *	Unknown	>8	under water
--			14:35	--	--	Cetaceans	Humpback Whales	≤ 20	--

Table 6. (Continued)

Survey Details (Continued)									
Waypoint	Longitude	Latitude	Time (HH:MM)	Weather		Sighting Information			
				BFS	Notes	Type	Species Common Name	No.	Comments
W009	-125.627	48.276	14:45	--	wind picking up slightly	--	--	--	--
W009	-125.627	48.276	15:00	--	--	--	--	--	Lots of floating debris
--	--	--	15:03	2-3	--	Cetaceans	Humpback Whales	3	may have been same group as previous sighting
--	--	--	15:10	--	--	Cetaceans	Humpback Whales	2	new group
--	-126.013	48.193	15:55	--	--	Sharks	Blue Shark	1	small; just under water
W008	-126.010	48.184	15:56	--	--	--	--	--	--
W008	-126.010	48.184	16:02	--	--	--	--	--	--
--	-125.901	48.235	16:24	3-4	--	Sharks	Blue Shark	1	4.5 feet long; almost directly under boat
--	-125.869	48.247	16:29	--	--	Sharks	Blue Shark	1	4.5 feet long
--	--	--	16:35	--	--	Sharks *	Unknown	1	near bull kelp
W007	-125.691	48.314	17:00	--	difficult to see because of waves	--	--	--	--

Table 7. The Beaufort Scale

Beaufort Scale Code	Description	Wind Speed (knots)	Sea State
0	Calm	<1	Sea like mirror
1	Light Air	1 – 3	Ripples, no foam crests
2	Light Breeze	4 – 6	Small wavelets
3	Gentle Breeze	7 – 10	Crests breaking
4	Moderate Breeze	11 – 16	Whitecaps
5	Fresh Breeze	17 – 21	Moderate waves - spray
6	Strong Breeze	22 – 27	Large waves
7	Moderate Gale	28 – 33	Sea heaps up
8	Fresh Gale	34 – 40	Moderately high waves
9	Strong Gale	41 – 47	High waves, spray
10	Whole Gale	48 – 55	Overhanging crests, sea white
11	Storm	56 – 63	Exceptionally high waves
12	Hurricane	64 – 118	Sea white

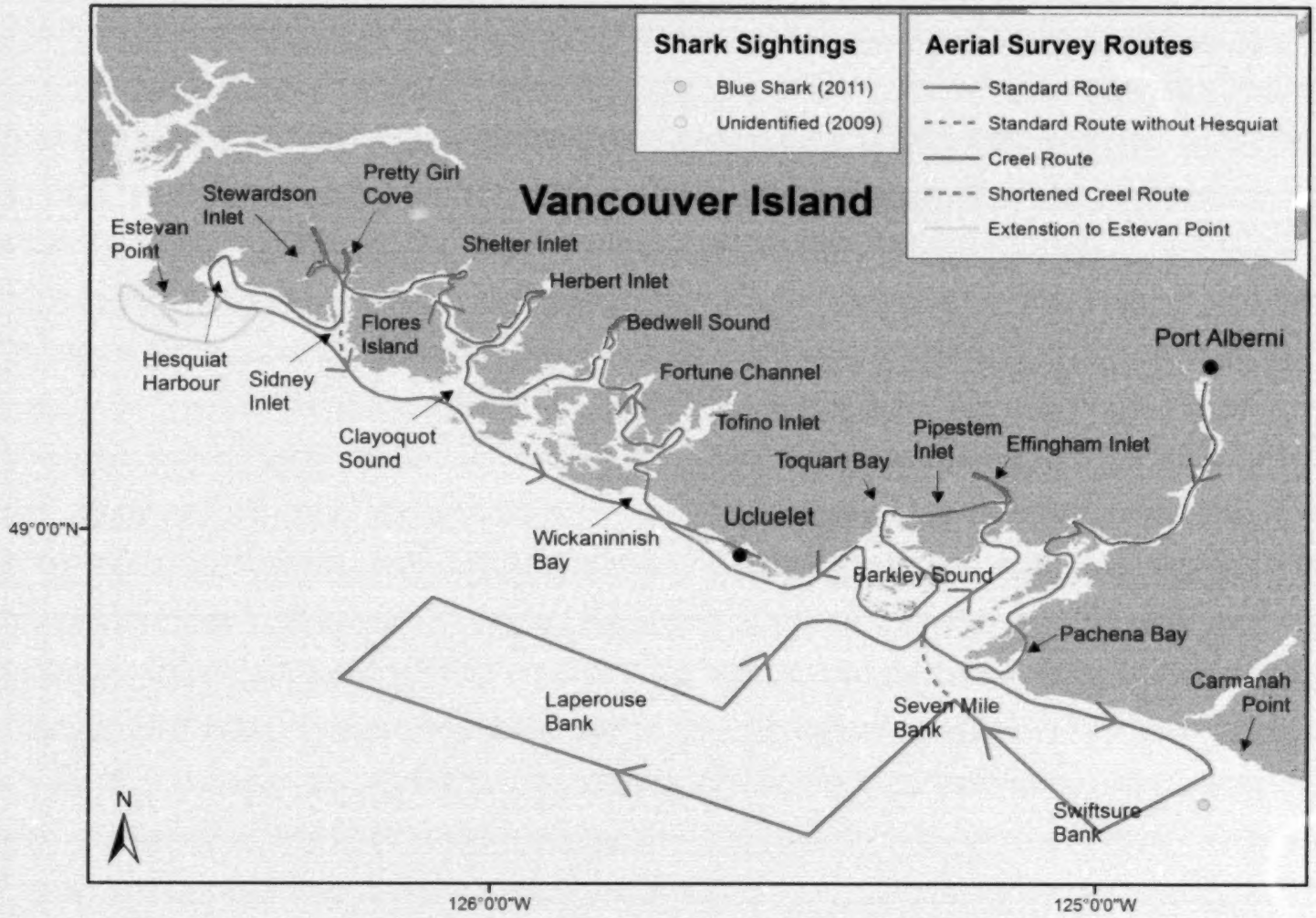

Figure 1. Basking Shark nearshore aerial survey routes and associated possible pelagic shark sightings on the west coast of Vancouver Island, 2007 – 2011.

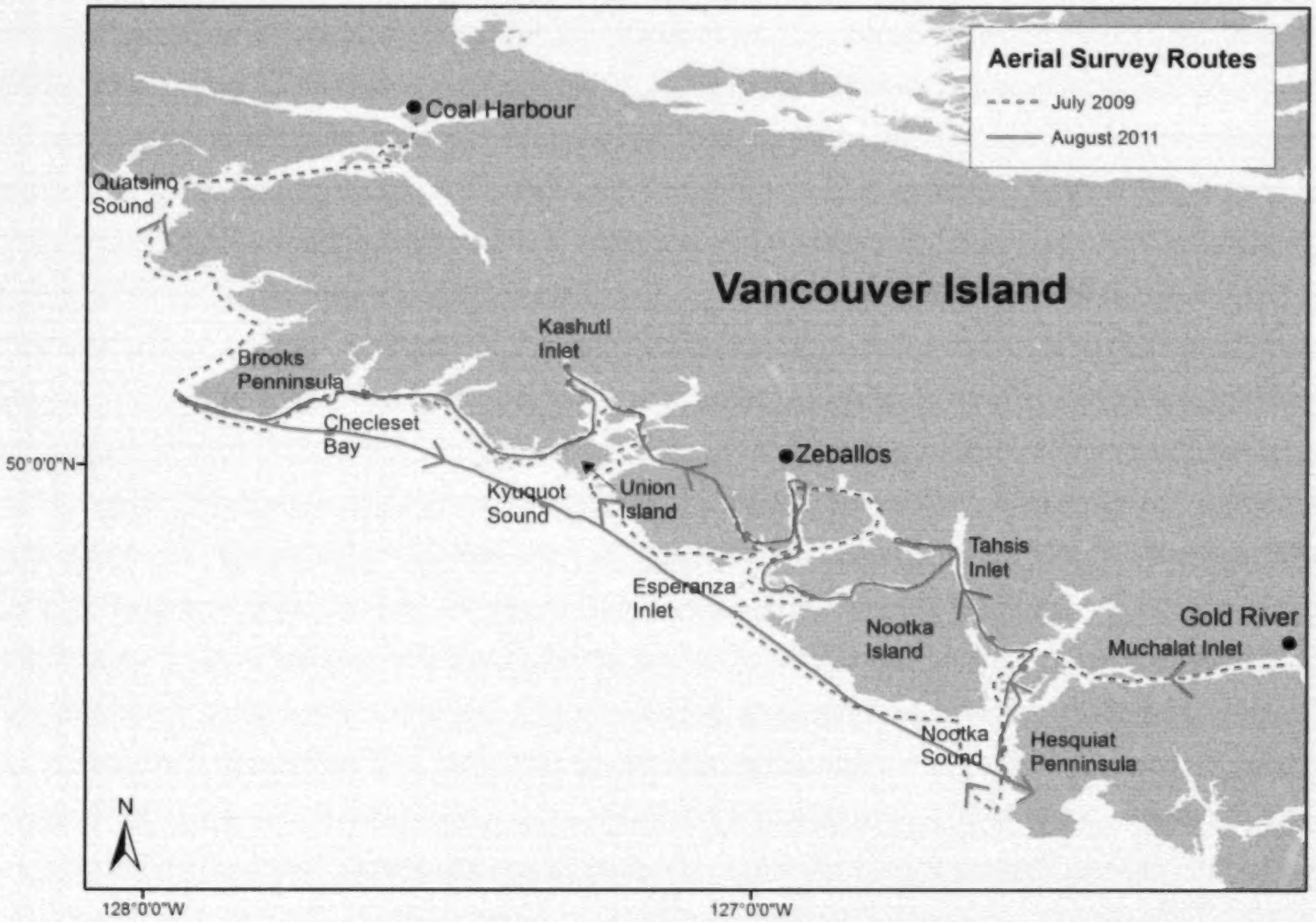

Figure 2. Basking Shark nearshore aerial survey routes on the northwest coast of Vancouver Island, 2009 and 2011.

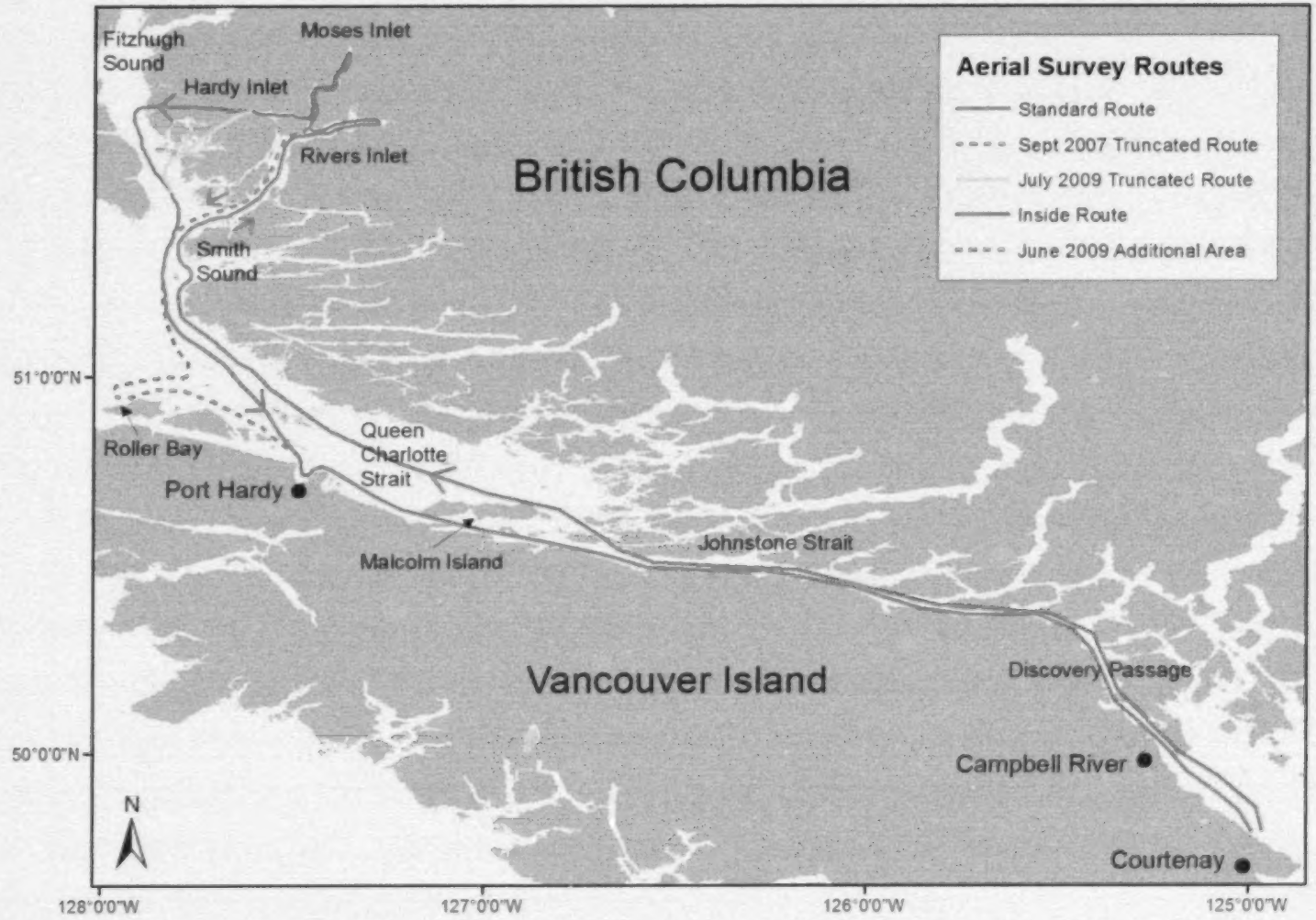

Figure 3. Basking Shark nearshore aerial survey routes covering Rivers Inlet, Queen Charlotte Strait, Johnstone Strait, and Discovery Passage, 2007 – 2010.

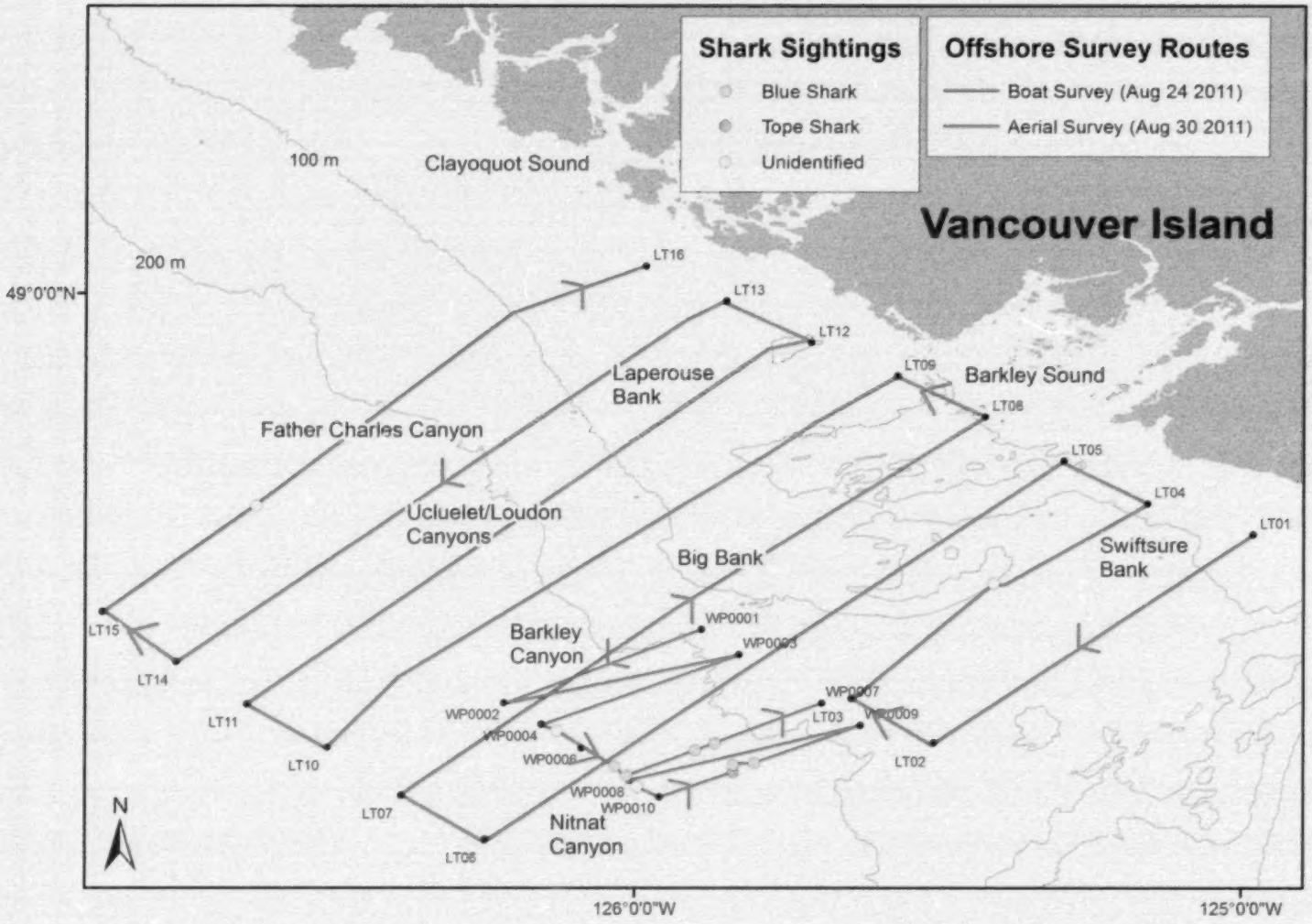

Figure 4. Basking Shark offshore aerial and boat-based survey routes and associated pelagic shark sightings on the west coast of Vancouver Island, August 24 and 30, 2011.

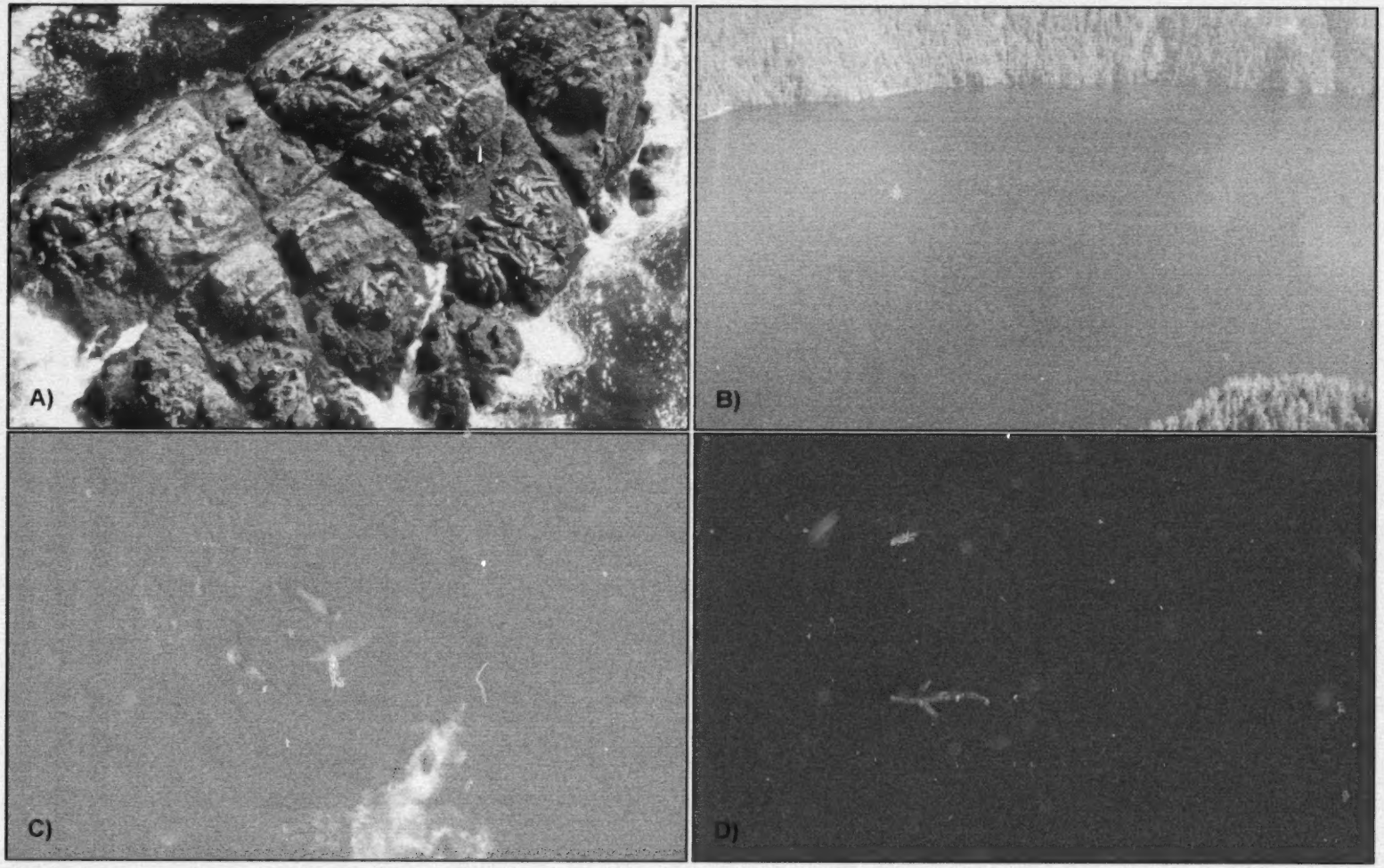

Figure 5. Examples of observations during Basking Shark aerial surveys: A) Steller Sea Lions (*Eumetopias jubatus*) in Barkley Sound, September 19, 2007; (B) plankton blooms in Tofino Inlet, September 19, 2007; (C) Humpback Whales (*Megaptera novaeangliae*) off Tsusiat Falls, October 3, 2008; (D) possible Blue Shark (*Prionace glauca*) near Swiftsure Bank, May 30, 2011.

Appendix A: Additional Aerial Surveys conducted by Fisheries and Oceans Canada in 2007 – 2011.

Throughout the period during which Basking Shark aerial surveys were taking place, other Fisheries and Oceans (DFO) programs conducted aerial surveys over some of the same locations, but no Basking Shark sightings were reported. Although spotting Basking Sharks was not the primary objective of these additional surveys, observers were aware of the Basking Shark program, and had agreed to report any suspected shark sightings.

Creel Surveys

DFO has used aerial surveys to estimate fishing effort for the recreational fishery in the northern Strait of Georgia (Johnstone Strait and Queen Charlotte Strait) since 1991 (Collicut et al. 1992), and off the west coast of Vancouver Island (WCVI) between Port Renfrew and Quatsino Sound since 2001; portions of WCVI have been surveyed since 1984 (Lewis 2004). On the west coast of Vancouver Island in 2007 – 2011, flights occurred in June – September and covered the coastline from Port Renfrew to Quatsino Sound, including Barkley Sound, Swiftsure Bank, La Perouse Bank, and Clayoquot Sound; they did not survey most inlets (Figure A1) (B. Wright, Fisheries and Oceans Canada, 3225 Stephenson Point Road, Nanaimo, BC V9T 1K3, personal communication; A. Pereboom, Fisheries and Oceans Canada, 8585 Wollason Street, Port Hardy, BC V0N 2P0, personal communication). In the northern Strait of Georgia in 2007 – 2011, flights occurred in June – August and covered Johnstone Strait and Queen Charlotte Strait (Figure A1) (A. Pereboom, Fisheries and Oceans Canada, 8585 Wollason Street, Port Hardy, BC V0N 2P0, personal communication). Flights occurred 1-2 times per week and altitude ranged from 90 – 210 m (300 – 700 feet). Creel survey flights are ongoing. No Basking Sharks have been reported from creel survey overflights to date.

Sardine trial overflights

In 2008 – 2011, DFO staff conducted trial overflights to assess the utility of aerial surveys for characterising sardine distribution in BC (L. Flostrand, Fisheries and Oceans Canada, 3190 Hammond Bay Road, Nanaimo, BC V9T 6N7, personal communication). In October 2008, a survey was conducted off the west coast of Vancouver Island (Alberni Inlet, Barkley Sound, Sydney Inlet, and offshore areas) at an altitude of approximately 2000 feet (600 m); as this was considered suitable for identifying marine mammals, it is assumed that any large sharks close to the surface would also have been observable (Figure A2a). In July 2011, a survey was conducted off the west coast of Vancouver Island (Barkley Sound, Fortune Channel, Clayoquot Sound, Hesquiat Harbour, Nootka Sound to Quatsino Sound) and over Queen Charlotte Strait and Central Coast (including Smith Inlet, the mouth of Rivers Inlet, and Fitzhugh Sound) at an altitude of 1000 – 1500 feet (300 – 450 m) (Figure A2b). No Basking Sharks were observed on either survey. Additional sardine surveys were conducted in 2009 and 2010, but the survey altitude was too high to be useful for observing Basking Sharks. Sardine overflights were discontinued after 2011.

Leatherback Sea Turtle and Cetacean Surveys

In August and September of 2006 and 2007, DFO staff conducted aerial surveys of the west coast of Vancouver Island targeting Leatherback Sea Turtles (*Dermochelys coriacea*), which also noted cetacean observations (Spaven et al. 2009). These surveys covered transects perpendicular to the continental shelf off the entire west coast of Vancouver Island at an altitude of 200 m (650 feet), but did not venture into inlets (Figure A2c). No Basking Sharks were

reported. While these surveys preceded the inaugural Basking Shark survey, and Basking Sharks were not a specific target, it is unlikely that a Basking Shark sighting would have gone unnoticed or unreported.

In October 2011, DFO staff began conducting aerial surveys of the west coast of Vancouver Island to detect and identify large whales; other marine mammals, sea turtles and large sharks would be recorded if sighted (L. Spaven, Fisheries and Oceans Canada, 3190 Hammond Bay Road, Nanaimo, BC V9T 6N7, personal communication). Transects cover the continental shelf and offshore areas between Swiftsure Bank and Esperanza Inlet at an altitude of 1000 feet, and do not cover inlets (Figure A2d). These surveys are ongoing, but no Basking Sharks have been observed to date.

References

Collicutt, L.D., Naito, B.G., Ryall, P., and Lapi, L. 1992. North Vancouver Island sport fishery creel survey statistics for salmon and groundfish, 1991. Can. Tech. Rep. Fish. Aquat. Sci. 1857: 121 p.

Lewis, D.M. 2004. West Coast Vancouver Island sport fishery creel survey statistics 2001 and historical data 1984-2000. Can. Manuscr. Rep. Fish. Aquat. Sci. 2639: 66 p.

Spaven, L.D., Ford, J.K.B, and Sbrocchi, C. 2009. Occurrence of leatherback sea turtles (*Dermochelys coriacea*) off the Pacific coast of Canada, 1931-2009. Can. Tech. Rep. Fish. Aquat. Sci. 2858: vi + 32 p.

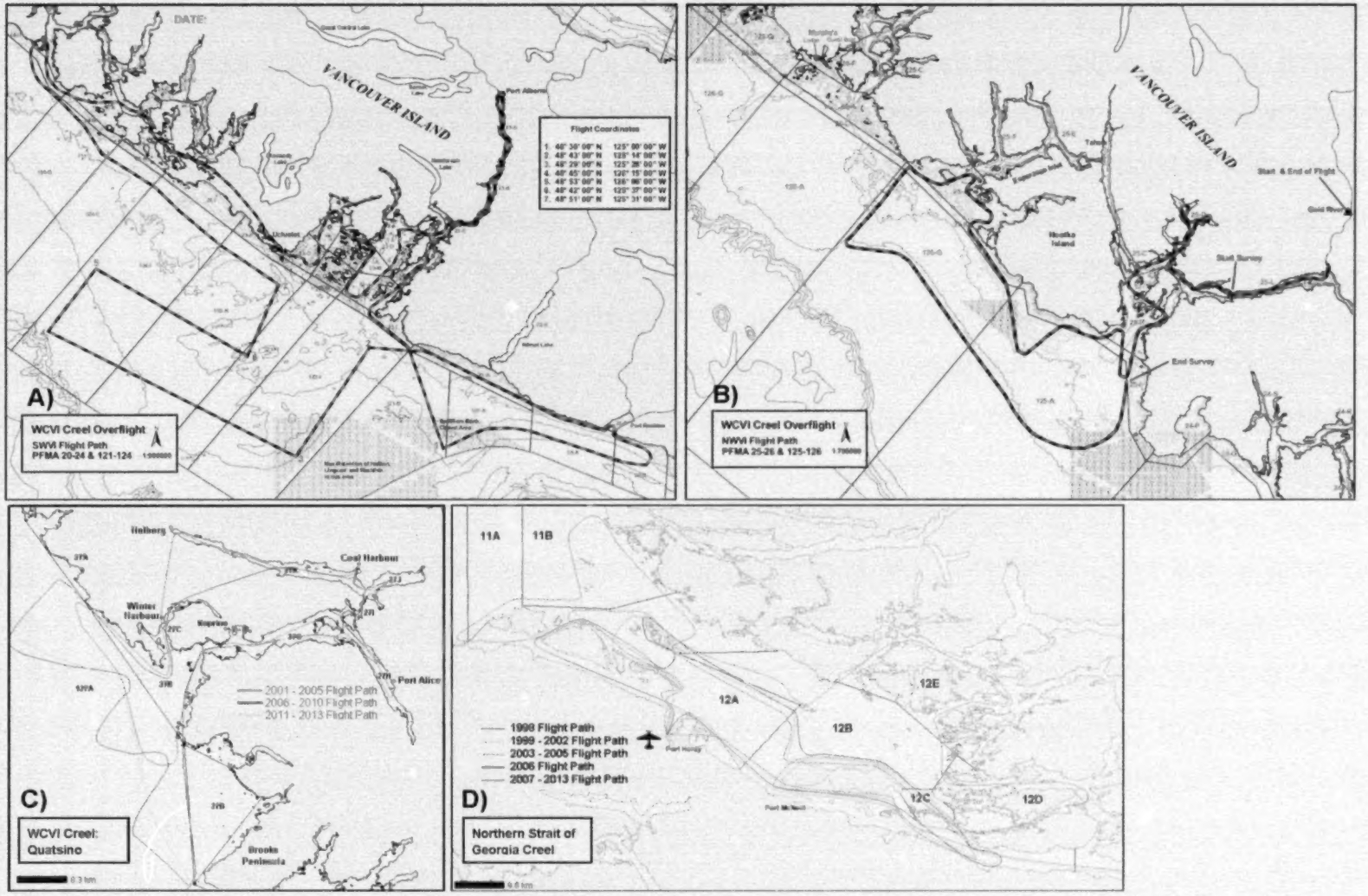

Figure A1. DFO Creel survey routes in 2007 – 2011 off the west coast of Vancouver Island (A-C) and in the northern Strait of Georgia (D). Figures provided by B. Wright and A. Pereboom.

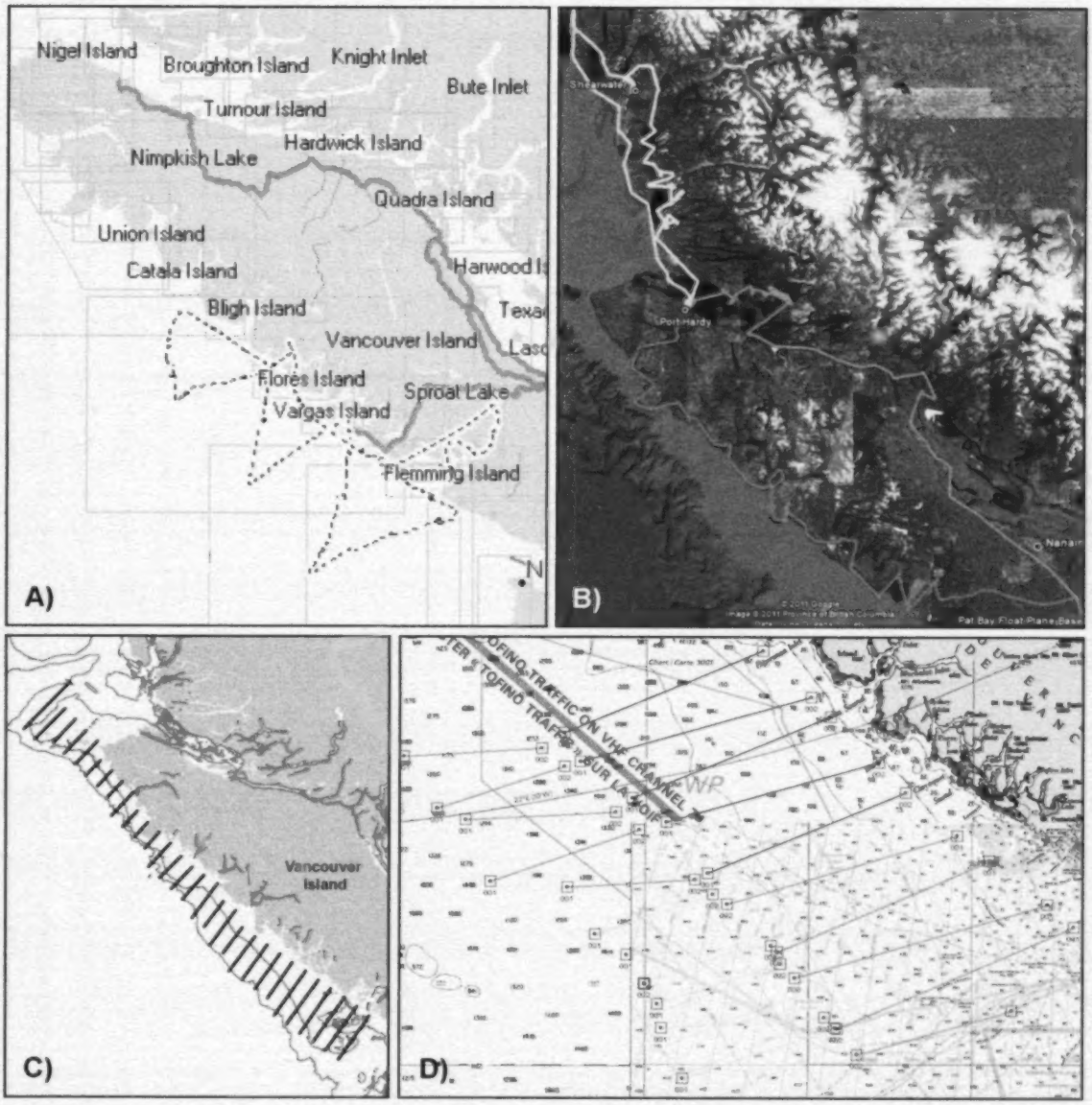

Figure A2. Flight paths for DFO aerial surveys in 2006 - 2011: (A) sardine trial overflights of the west coast of Vancouver Island in 2008 and (B) sardine trial overflights of the west coast of Vancouver Island, Strait of Georgia, and Central Coast in 2011 (Figures provided by L. Flostrand); (C) Leatherback Turtle surveys of the west coast of Vancouver Island in 2006 - 2007 (Figure from Spaven et al. 2009); (D) Cetacean surveys of the west coast of Vancouver Island in 2011 (Figure provided by L. Spaven).